

# CORYNOTRYPA, A NEW GENUS OF TUBULIPOROID BRYOZOA.

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## INTRODUCTION.

The present paper discusses all the known species of a supposed new genus of simple tubuliporoid Bryozoa, and may be said, therefore, to be monographic in its scope. However, the prime object of the article is the determination of the specific variation in a group of tubular organisms, which, on account of their minute size and extreme simplicity as well as alleged great variability of structure, have presented difficulties of classification.

In almost every class of natural history in which tubular organisms occur, the classification of these simpler types has proved more difficult than that of their more complicated allies. This is particularly true in the case of the Bryozoa where the simplest of such tubular forms are grouped under the family Tubuliporidae, in the order Cyclostomata. A wide difference of opinion has obtained even among the best students as to the classificatory value of the few and supposedly quite variable characters exhibited by these types, and their literature therefore presents varying degrees of exactness. For example, Waters, an excellent but very conservative student, considered the early Ordovician form *Mitoclema cinctosum* to be the same as the late Mesozoic *Spiropora verticillata*, while Haime included in one species specimens which d'Orbigny had divided among five genera. In spite of such extreme views there is a growing tendency among present-day students to recognize as genera in these simple bryozoans those groups, distinguished mainly by method of growth, around which the various species may be assembled. Gregory <sup>a</sup> has given an interesting discussion on the value of generic divisions in the Cyclostomata, arriving at the conclusion that the terms *Stomatopora*, *Proboscina*, and like names applied to the simple bryozoans, might be accepted, not as generic names in the sense in which this term is used in the higher groups of animals, but as designations for convenient groups not altogether artificial. He says: "They could

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<sup>a</sup> Cat. Foss. Bryozoa British Museum, The Jurassic Bryozoa, 1896, pp. 14-22.

be better described as circuli than as genera. A *circulus* was one of the small groups of individuals who clustered round speakers in the Roman forum. Most of the individuals in the forum were definitely attached to a particular group; the groups were less crowded around their margins, and between them people were irregularly scattered and crossed from circulus to circulus. They thus prevented any rigid division of the crowd into definite groups."

While Gregory's view of genera among the simple Cyclostomata is a very ingenious one, still it seems to me that no distinction need be made between the conception of a genus of Bryozoa and that of any other group of organisms. It must always be recognized that sharply outlined genera are impossible in any class, and that generic names are instituted for convenience in designating a series of organisms having certain characters in common, as well as to show natural affinity. The middle forms of such a series will have the most distinctive characters, while those at either end often show relationships to allied groups of species.

The simplest of the tubuliporoid bryozoans comprise the forms in which the zoëcia are adnate and arranged uniserially. To-day most writers restrict the genus *Stomatopora* Bronn to such unilinear species. More complex, adnate species have the zoëcia arranged in two or more rows and are generally referred to the genus *Proboscina* Audouin, while zoaria of incrusting circular or irregular patches, resulting from the union of numerous contiguous zoëcia, belong to Lamouroux's genus *Berenicea*. The present article deals only with simple, unilinear forms, which, as stated above, have hitherto been classed as *Stomatopora*.

My experience with *Stomatopora* began some years ago with the two very abundant Ordovician forms, *S. arachnoidea* and *S. inflata* Hall. These two species are so different that I could never reconcile their recognition as species of the same genus; but it is only recently that sufficient material has been accumulated in the collections of the U. S. National Museum to warrant a close study of the subject. Now all of the known Paleozoic and most of the Mesozoic and later forms of the genus are represented by specimens, and of many of them the material is abundant enough to fairly test their hitherto commonly supposed great instability in specific characters. The present paper is therefore based upon a study of thousands of specimens from widely separated localities and from many horizons in the geologic column.

The two Ordovician species mentioned above being the most numerously represented, received a correspondingly greater amount of study. *S. arachnoidea* is essentially like the Jurassic *S. dichotoma*, the genotype of *Stomatopora*, but the zoëcia of *S. inflata* are so different and its peculiarities are so constantly reproduced in a long line of descendants, that it seems desirable to establish a new genus

for them. Thus, while the typical forms of *Stomatopora* have zoecia with more or less parallel sides and no narrow, elongated, proximal portion, and large, open, exsert apertures, the new genus comprises the uniserial, adnate tubuliporoids in which the individual zoecia are contracted at their proximal end and rounded at the distal or apertural portion. The latter type of structure pertains to species ranging from the base of the Ordovician to the close of the Mesozoic, and the known representatives are divisible into no less than sixteen species. Considering these facts and also that the species are always easily distinguished from the typical forms of *Stomatopora*, I propose for them the new name *Corynotrypa*, in reference to the club-shaped

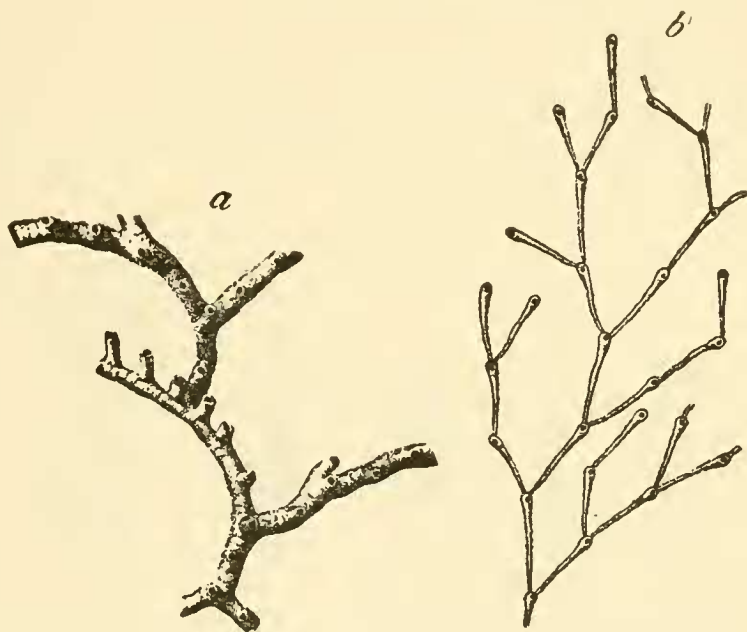


FIG. 1.—GENOTYPES OF STOMATOPORA AND CORYNOTRYPA, ILLUSTRATING GENERIC DIFFERENCES. *a*, STOMATOPORA DICHOTOMA. JURASSIC, HAMPTON CLIFFS, ENGLAND. (AFTER HAIME.) *b*, CORYNOTRYPA DELICATULA. UPPER ORDOVICIAN, CINCINNATI, OHIO. (AFTER ULRICH.)

zoecium with the perforation or zoecial aperture at its swollen end. The differences between the genus *Stomatopora* as thus restricted and the new genus *Corynotrypa* are brought out in figure 1.

#### TERMINOLOGY.

On account of the great simplicity of the clavate zoecia, and the constant difficulty in discriminating closely allied forms, it has been found useful to employ the following terms in their descriptions. The slender, proximal portion (*s*) of the zoecium (figure 2),<sup>a</sup> is seen to vary

<sup>a</sup> All of the original illustrations in this paper have been prepared by Miss Frances Wieser from camera lucida sketches drawn by the author. Great care has been taken to secure exactness of measurement, especially in the angle of divergence. Whenever a specimen did not show its characters clearly under the microscope, it was whitened by one of the several processes employed for this purpose. A thin coat of some white substance applied to apparently indistinct specimens often brings out their structure with astonishing clearness.



greatly in length, indeed a considerable variation exists in individual zoëcia of the same zoarium. For convenience this portion is called the stolon. The true zoëcial, and therefore specific characters can be expressed only in those portions of the zoarium lodging mature animals. Obviously the slender stolons of the typical species of *Corynotrypa* could not lodge normal polypides, and this portion is consequently deemed of subordinate specific value. The stolon may be said to correspond to the immature zone of a zoëcium in a trepostomatous bryozoan. The normal polypide undoubtedly was limited to the expanded portion of the zoëcium (*z*) which is here designated as the zoëcium proper or simply the zoëcium. This portion has several characteristics which are very constant within specific limits. First, and taxonomically most useful of such characters, is the size of the zoëcia, which, when the variable stolons are eliminated, is remarkably constant. The angle of divergence of a zoëcium (*g*), obtained by measuring the rate of expansion of its sides from the

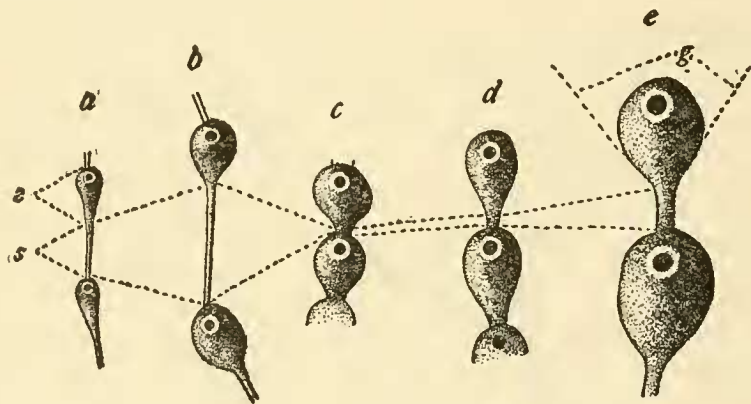


FIG. 2.—CHARACTERISTIC SPECIES OF *CORYNOTRYPA*,  $\times 20$ , ILLUSTRATING VARIATION IN STOLON (*s*) ZOËCIUM PROPER (*z*), AND ANGLE OF DIVERGENCE (*g*). *a*, *CORYNOTRYPA DELICATULA*; *b*, *C. ABRUPTA*; *c*, *C. CURTA*; *d*, *C. INFLATA*; *e*, *C. TURGIDA*.

distal end of the stolon, has likewise proved of much value in identifying the different types. Less useful criteria, and generic rather than specific in significance, are the position and relative size of the zoëcial aperture and its encircling peristome. As a rule the aperture is subterminal and has a diameter about one-third that of the zoëcium at its greatest width. The walls are similarly porous in this as well as in many other cyclostomatous genera, so that the minute structure of the walls offers little help in distinguishing either species or genera. However, one section of *Corynotrypa* contains species in which the walls are transversely wrinkled so that the character of the zoëcial surface is, therefore, not to be entirely ignored.

In brief, then, after determining from its uniserial growth and clavate zoëcia that a form belongs to this new genus, the species may be determined almost wholly by the size and general outline of the zoëcium proper, and, under the latter, especially by its angle of



divergence. The differences, while often very slight, hold so well that little difficulty is encountered in recognizing species the world over. For example, the genotype, *Corynotrypa delicatula*, and the well-known *C. inflata*, so common in numerous Ordovician horizons of America, have been recognized at several European localities. *C. abrupta*, *C. dissimilis*, *C. barberi*, and *C. elongata* are likewise nearly cosmopolitan forms.

With these points of terminology in mind, the genus may be defined as follows:

CORYNOTRYPA, new genus.

Zoarium adnate, consisting of simple, subtubular zoëcia arranged in single-branched series; zoëcia oval-pyriform to elongate clavate, the proximal end constricted and united with the preceding zoëcium by a narrow, tubular stolon of variable length; the distal portion more or less expanded and bearing on its frontal side the aperture which is subterminal, circular, and inclosed by a more or less distinct, slightly elevated peristome; walls finely porous.

Genotype, *Stomatopora delicatula* James. Ordovician of America and Europe. Range of genus, base of Ordovician to close of Mesozoic; probably also Cenozoic.

The closest ally of *Corynotrypa* is undoubtedly the well-known and even more widely distributed and longer-lived *Stomatopora*. The two genera agree in having an incrusting zoarium composed of simple, porous, tubular zoëcia arranged uniserially. *Corynotrypa* differs from *Stomatopora* most obviously in the constriction of the proximal end of the zoëcium, giving it the characteristic clavate to pyriform shape which causes each to stand out as an individual. In *Stomatopora* the successive zoëcia form a narrow branch with more or less parallel sides in which the individuals are scarcely delimitable except by their apertural openings.

Among the species referred to *Corynotrypa*, the proximal constriction is most evident in those assigned to the *C. inflata* and the *C. delicatula* groups discussed later, but becomes less marked in such forms as *C. canadensis* and *C. dissimilis*. The last two represent a third group in which the generic relationship to *Stomatopora* is much more obvious. In addition to the shape of the zoëcium, the aperture in *Corynotrypa* likewise presents good generic characters. In typical *Stomatopora* the aperture is exsert, usually slightly tilted forward, and often almost equals the zoarial branch in diameter. *Corynotrypa*, in its two principal groups, has a small, neatly constricted aperture, never exsert, with a width about one-third that of the branch and surrounded by a low but distinctly marked peristome. In the third or *C. dissimilis* group of *Corynotrypa*, the nearer relation to *Stomatopora* is again expressed, in that the zoëcial apertures are occasionally exsert and of unusual width. •

Altogether it is believed that the club-shaped zoëcia produced by the constriction of the proximal end, and the small, neatly constricted aperture with low peristomes, constitute sufficient characters to justify a new genus, although it is recognized that several intermediate forms exist between this genus and *Stomatopora*, as here restricted.

This new cyclostomatous genus, in its method of growth and general shape of the zoëcia is quite similar to genera of other orders, an occurrence which is not unusual in the Bryozoa. Such species as *Corynotrypa nitida* or *C. tenuichorda* are exceedingly like elongate, delicate forms of *Hippochoa*, and might readily be confused. The latter genus, however, a representative of the Chilostomata, has a sinus in the lower margin of the aperture and an occasional well-marked oëcium, as well as a very delicate surface ornamentation quite different, on close examination, from the simple punctate structure of *Corynotrypa*. Among the Ctenostomata such genera as the recent *Arachnidium* and the fossil *Rhopalonaria* are so similar in general shape to *Corynotrypa* that at least one species of the last genus was originally referred to the second.

#### GEOLOGIC DISTRIBUTION.

The geographic distribution of *Corynotrypa* has been briefly indicated in previous remarks, and is also shown in the description of the species. Regarding its geologic range, it is interesting to note that the two typical sections of the genus show a somewhat parallel specific development. Thus, in the Ordovician, the most abundant, *C. delicatula*, with a long geologic range, is accompanied through a considerable part of this time by the equally abundant *C. inflata*. During earliest Silurian, when the deposits of the Richmond group were being laid down, conditions seem to have been favorable for the development or introduction of new, somewhat bizarre species, which apparently did not survive for any great length of time. Among these are the unusually large, swollen form, *C. turgida*, another equally well marked species, *C. curta*, differing, however, in being exceptionally small and short, and, lastly, *C. abrupta*, with a long, slender stolon and short, greatly swollen zoëcium.

In the Silurian, succeeding Richmond time, no representative of the *C. inflata* section has been discovered so far, but the Devonian contains a delicate species of each section. The next known occurrence of the genus is in the Mesozoic, where, as shown in the table on page 504, again a single species of each section appears. The apparent absence of the genus in the known Mississippian, Pennsylvanian, and Permian rocks may be due to lack of systematic search, but it is nevertheless a curious fact that all of the simple cyclostomatous

bryozoans have a similar geologic distribution. *Stomatopora*, *Proboscina*, *Berenicea*, and other genera, although well developed before and after, have no known representative during Carboniferous time.

VARIATIONAL FORMULAS.

The extreme variability of these simple Cyclostomata has been recognized by many writers, with the result that the conception of a species has often changed with each author's study. Gregory has recognized this variation and has suggested the identification of species by means of variational formulæ. For the simple, incrusting forms, such as those discussed in this paper, he uses four main features, namely, the character of the peristome, the shape of the zoœcia, the length of the zoœcia, and, finally, the general aspect of the zoarium. Thus, for *Stomatopora*, the terms of his formula are as follows:

	Peristome.	Shape of zoœcia.	Length of zoœcia.	Zoarium.
	<i>p.</i>	<i>c.</i>	<i>l.</i>	<i>r.</i>
0	Flush.....	Cylindrical.....	Short.....	Uniserial; long thin series.
1	Slightly raised.....	Fusiform.....	Medium.....	Uniserial; branches tufted at ends.
2	Well raised.....	Pyriiform.....	Long.....	Uniserial; branches tend to become double at ends.
3	Highly raised.....	Hippothoiform....	Very long.....	Multiserial.

Applying his method to *Stomatopora dichotoma* (Lamouroux), illustrated on page 499, its formula would be as follows:

$$Stomatopora\ dichotoma\ (Lamouroux) = \frac{p.}{2} \frac{c.}{0} \frac{l.}{1} \frac{r.}{1}$$

However, a new scheme would be necessary for the species formerly assigned to *Stomatopora* but here described as *Corynotrypa*, since two of the terms—the length and outline of zoœcia, including the stolon—vary considerably in the same species, and the two remaining terms, the peristome and the zoarium, are practically always the same. For example, the formula for *Corynotrypa inflata*, as illustrated in figures 12 and 13, would be as below:

$$Corynotrypa\ inflata\ (Hall) = \frac{p.}{1} \frac{c.}{1-2-3} \frac{l.}{0-1-2-3} \frac{r.}{0}$$

Of course it is recognized that the latter is an extreme case and that the formula for this species should be based upon normal zoœcia only, as shown in figure 2*d*. The terms of the formula quoted above probably will serve very well for species of the genus *Stomatopora* as here restricted.

For *Corynotrypa*, it is believed that a division into three sections, based mainly upon the angle of divergence of the zoœcial walls, is preferable and of more value in the identification of species.



## SUBDIVISIONS OF CORYNOTRYPA.

Three fairly distinct subdivisions of *Corynotrypa* may be recognized, with, however, one or more intermediate species connecting them. These, from their most characteristic species, may be known as (1) the *C. delicatula* section, with long, exceedingly slender zoëcia enlarging very slowly and always remaining quite narrow at the apertural portion; (2) the *C. inflata* section, in which the zoëcia enlarge rapidly after the slender, proximal stage is passed; and (3) the *C. dissimilis* section, with broad, stout, little constricted zoëcia and often distinguished in addition by a surface ornamentation of transverse lines. At least two quite dissimilar species, *C. schucherti* and *C. canadensis*, are known, connecting the second and third sections, while another well-marked form, *C. barberi*, appears to be intermediate between sections 1 and 2. Merely for convenience of classification, the difference in the angle of divergence of the apertural portion of each zoëcium is selected as the most distinctive character of the first and second sections. According to this scheme, the species of *Corynotrypa* are distributed among these sections as follows:

## CORYNOTRYPA DELICATULA SECTION.

Angle of divergence small, proximal constriction well marked, aperture constricted and with peristome.

Species.	Angle of divergence.	Geologic range.
<i>C. delicatula</i> (James).....	15°	Ordovician and early Silurian.
<i>C. barberi</i> , new species.....	30°	Do.
<i>C. elongata</i> (Vine).....	25°	Silurian.
<i>C. nitida</i> , new species.....	20°	Devonian.
<i>C. tenuichorda</i> (Ulrich and Bassler) <sup>a</sup> .....	30°	Cretaceous.

<sup>a</sup> Several of the Cretaceous species of *Stomatopora*, figured by d'Orbigny in the fifth volume of *Paleontologie Française*, appear to have the characters of *Corynotrypa*, but in view of that author's diagrammatic and frequently incorrect illustrations I have hesitated to refer them to the genus without a study of actual specimens.

## CORYNOTRYPA INFLATA SECTION.

Angle of divergence great, proximal constriction well marked, aperture constricted and with peristome.

Species.	Angle of divergence.	Geologic range.
<i>C. inflata</i> (Hall).....	40°	Ordovician and early Silurian.
<i>C. abrupta</i> , new species.....	50°	Early Silurian.
<i>C. curta</i> , new species.....	70°	Do.
<i>C. medialis</i> , new species.....	50°	Do.
<i>C. turgida</i> (Ulrich).....	70°	Do.
<i>C. devonicta</i> (Oehlert).....	40°	Devonian.
<i>C. smithi</i> (Phillips).....	40°	Jurassic.

## CORYNOTRYPA DISSIMILIS SECTION.

Angle of divergence very small, proximal constriction less distinctly marked, aperture slightly exsert, little constricted, walls transversely wrinkled or smooth.

Species.	Geologic range.
<i>C. dissimilis</i> (Vine).....	Silurian.
<i>C. tennesseensis</i> , new species.....	Ordovician.
<i>C. schucherti</i> , new species.....	Do.
<i>C. canadensis</i> (Whiteaves).....	Do.

## CORYNOTRYPA DELICATULA SECTION.

At least four species are known with characters so similar to the genotype that they may be grouped with it into a section of the genus as designated above. On account of their relations to *C. delicatula*, these five species naturally are the most typical forms of *Corynotrypa*, although the following *C. inflata* section comprises very similar, congeneric forms. In the present section the club-shaped zoecia are very delicate and usually greatly elongated, the slender stolon being almost always well developed. The angle of divergence in the zoecia proper is so slight that some care is required to determine the distal end of the stolon. This angle is about  $15^\circ$  in *C. delicatula*, and ranges from this to  $30^\circ$

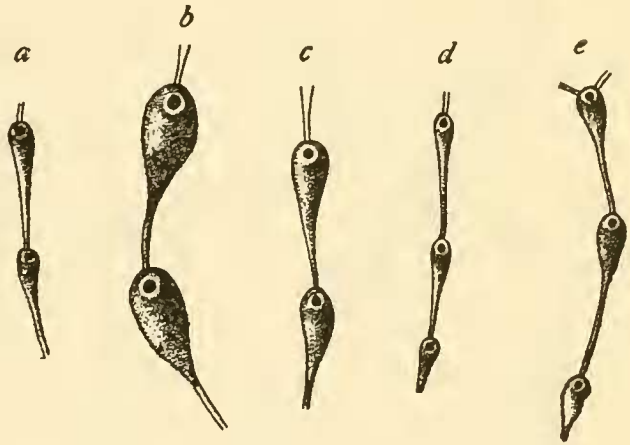


FIG. 3.—CORYNOTRYPA DELICATULA SECTION. GROUP OF ZOECIA,  $\times 20$ , SHOWING SPECIFIC DIFFERENCES. *a*, CORYNOTRYPA DELICATULA; *b*, *C. BARBERI*; *c*, *C. ELONGATA*; *d*, *C. NITIDA*; *e*, *C. TENUICHORDA*.

in other species of the section. The aperture in both this and the *C. inflata* section agrees in being constricted, with a diameter about one-third that of the zoecium, and in being surrounded by a distinct peristome. Views of average zoecia, equally magnified, of the five species referred to this section of the genus, are assembled in figure 3 for convenience of comparison.

*Specific variation.*—For reasons which will shortly be apparent, this section exhibits an astonishing amount of variation in the same species. This has been studied in only the type species on account of abundant material, but similar variation will no doubt be found in the other members of the section. Indeed, the variation is so great in *C. delicatula* that at least four distinct names have been applied to the species. The types, or typical specimens of these

four are in the collections of the U. S. National Museum, and their study, in connection with numerous other examples, soon revealed the fact that this extreme variation is due, not to the zoëcium proper, but to the stolon. Single zoaria were found exhibiting, in individual zoëcia, all the differences attributed to the supposed four distinct species. Such a zoarium is shown in figure 4, in which the usual relation between the length of the stolon and the zoëcium

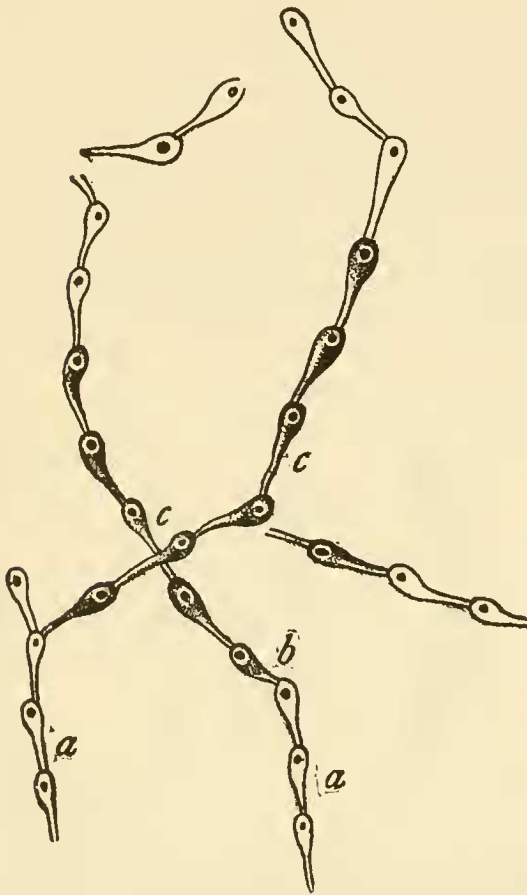


FIG. 4.—CORYNOTRYPA DELICATULA. ZOARIUM,  $\times 12$  ILLUSTRATING VARIABLE LENGTH OF STOLON. ORDOVICIAN, CORRYVILLE BEDS OF McMILLAN FORMATION, CINCINNATI, OHIO. FOR LETTERING SEE TEXT.

proper is shown at *a*. At *b* the stolon is almost entirely absent, but the zoëcium has the normal shape, size, and angle of divergence. However, zoëcia in the same linear series, as at *c*, may develop stolons of considerable length. It will be observed in each of these cases that the size and shape of the zoëcium proper, and its angle of divergence, in addition to such characters as the position and size of the aperture, has remained constant. The stolon is obviously the variable character, and, eliminating it, one can not attribute such unusual variability to these simple types as has been done.

The cause of this variable development of the stolon seems to be a purely physical one, due almost entirely to the habitat of the species. For instance, again using the example figured above, the zoëcia at *a* are incrusting a smooth plane surface; at *b* there is a depression just wide enough to accommodate a short zoëcium, while at *c* the surface is slightly roughened, and the zoëcium, to avoid this unfavorable spot, develops a stolon of greater length.

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#### CORYNOTRYPA DELICATULA (James).

*Hippothoa delicatula* JAMES, Paleontologist, no. 1, 1878, p. 6.

*Stomatopora delicatula* NICKLES and BASSLER, Bull. U. S. Geol. Surv., no. 173, 1900, p. 419.—BASSLER, Proc. U. S. Nat. Mus., vol. 30, 1906, p. 55, pl. 3, figs. 4-7.

*Stomatopora proutana* MILLER, Journ. Cincinnati Soc. Nat. Hist., vol. 5, 1882, p. 39, pl. 1, figs. 4-4b.—ULRICH, Geol. and Nat. Hist. Surv. Minnesota, Final Rep., vol. 3, pt. 1, 1893, p. 117, pl. 1, figs. 8-12.

*Rhopalonaria pertenuis* ULRICH, Fourteenth Ann. Rep. Geol. and Nat. Hist. Surv. Minnesota, 1886, p. 59.



*Stomatopora tenuissima* ULRICH, Journ. Cincinnati Soc. Nat. Hist., vol. 12, 1890, p. 175, fig. 2; Geol. and Nat. Hist. Surv. Minnesota, Final Rep., vol. 3, pt. 1, 1893, p. 116, pl. 1, figs. 16, 17.

*Stomatopora delicatula-tenuissima* NICKLES and BASSLER, Bull. U. S. Geol. Surv., no. 173, 1900, p. 419.

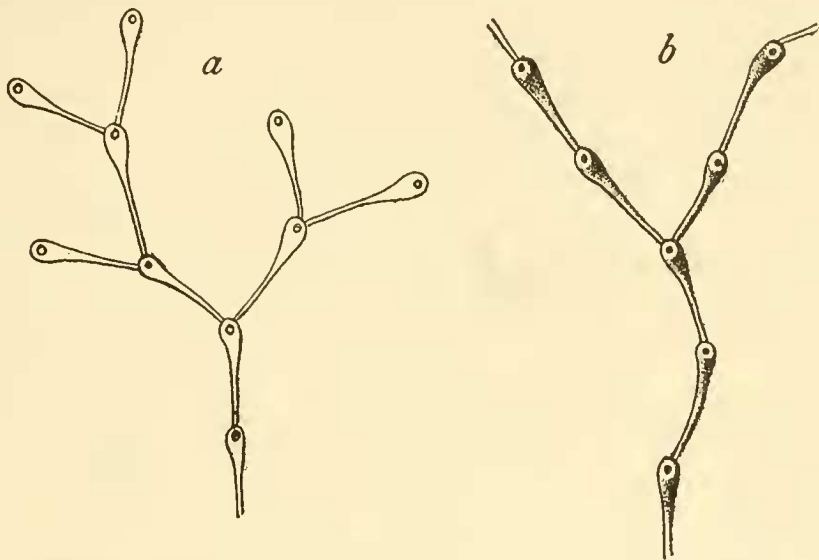


FIG. 5.—CORYNOTRYPA DELICATULA. *a*, VIEW OF AN AUTHENTIC SPECIMEN OF THE TYPICAL FORM  $\times 12$ , INCrustING A RAMOSE BRYOZOAN. ORDOVICIAN, ECONOMY BEDS OF EDEN FORMATION, CINCINNATI, OHIO; *b*, PART OF A ZOARIUM,  $\times 12$ , GROWING UPON THE EPITHECA OF AN EXPLANATE BRYOZOAN. ORDOVICIAN, OTTOSEE SHALE, KNOXVILLE, TENNESSEE.

*Original description.*—

“Polyzoary creeping, adnate, branching dichotomously, and sometimes anastomosing. Branches linear, about one-tenth of a line in diameter. Cells uniserial, each growing by a pointed base from the cell below, and expanding gradually to the mouth; two or three cells in the space of a line. Apertures terminal, elevated, and nearly or quite the diameter of the cells and placed on their front face.”

To James's original description the following remarks may be added. Strictly speaking, the zoecia do not gradually expand from a pointed

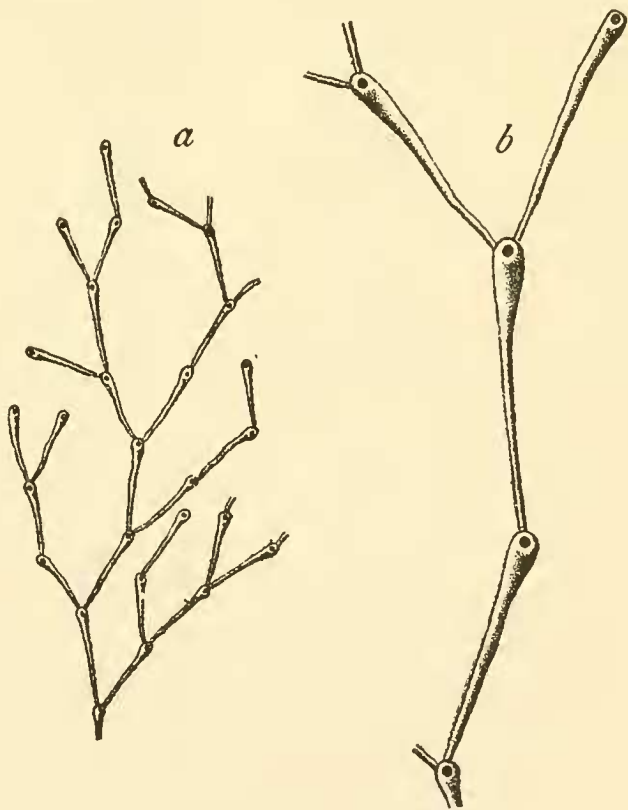


FIG. 6.—CORYNOTRYPA DELICATULA, *a* AND *b*, THE TYPE-SPECIMEN OF STOMATOPORA TENUISSIMA,  $\times 9$  AND  $\times 25$ . ORDOVICIAN, ECONOMY BEDS OF EDEN FORMATION, CINCINNATI, OHIO. (AFTER ULRICH.)

base, but, as indicated in the several sets of figures illustrating this species, the slender part of the zoecium, here styled the

stolon, is of uniform diameter for some distance in the elongated forms. The gradual increase in diameter begins with the zoëcium proper. The dimensions for the various forms of the species are as follows: The zoëcia in the slender, elongate form shown in figure 6 average seven in 8 mm., while each, including the stolon, is from 1 mm. to 1.5 mm. long and from 0.11 mm. to 0.18 mm. at its greatest diameter. The slender proximal or stolonial portion in this form, as well as the others to be mentioned, is about 0.04 mm., while the aperture itself is slightly wider, averaging 0.05 mm. In figure 7 the short form of the species is illustrated. Here the measurements are practically the same as those given above, except that the zoëcia vary from 0.6 mm. to 0.8 mm.

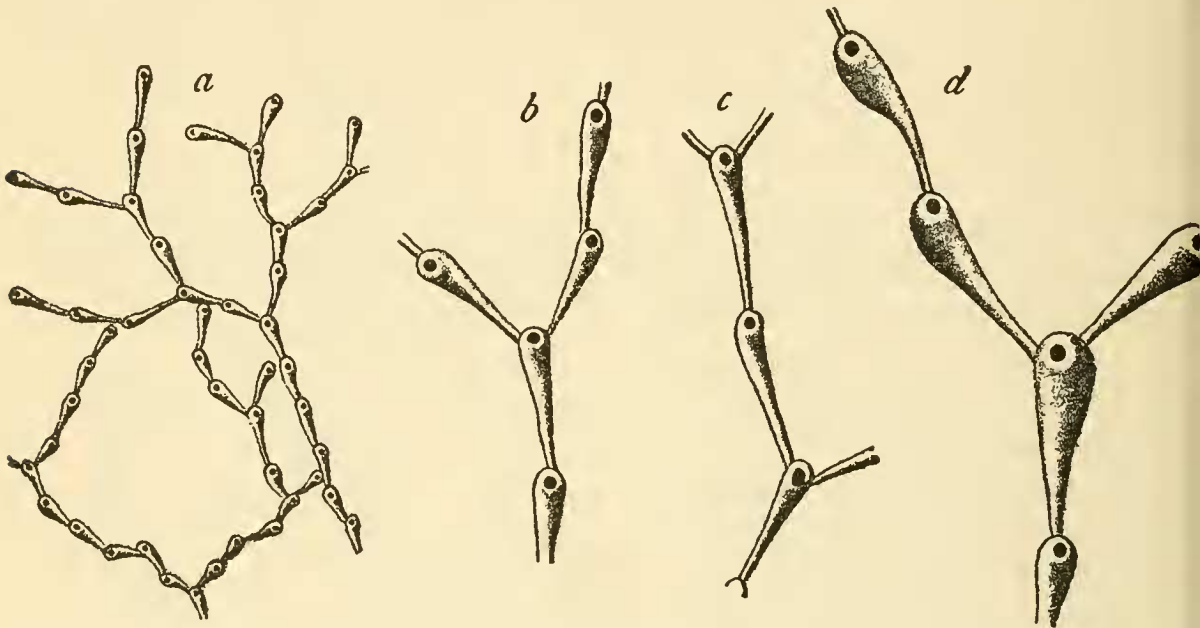


FIG. 7.—*CORYNOTRYPA DELICATULA*. SPECIMENS FIGURED BY ULRICH AS *STOMATOPORA PROUTANA*. *a*, FRAGMENT OF A ZOARIUM,  $\times 9$ ; *b* AND *c*, TWO GROUPS OF ZOECIA,  $\times 25$ ; *d*, SEVERAL ZOECIA OF UNUSUAL SIZE,  $\times 25$ . ORDOVICIAN, BLACK RIVER GROUP, ST. PAUL AND MINNEAPOLIS, MINNESOTA. (AFTER ULRICH.)

in length, and 8 to 10 occur in 5 mm. Several unusually large zoëcia are illustrated in figure 7*d*, but such specimens are of rare occurrence and even here the measurements are all in proportion to those of the typical specimens. In all of these various specimens the length of the zoëcium proper is approximately the same and its angle of divergence remains about  $15^\circ$ .

The considerable variation in the length of the stolon of this species has been discussed before and specific differences based upon this character have not been maintained, as noted in the synonymy above. At certain horizons, particularly in the McMillan formation at Cincinnati, Ohio, very luxuriant growths of *C. delicatula* are found and it is in such specimens that the greatest variation is exhibited.

Miller applied the name *Stomatopora proutana* to the very elongate form from the Corryville bed at Cincinnati, while specimens with the same characters but coming from the lower part of the Eden shale were described as *S. tenuissima* by Ulrich. The form with short zoëcia was named *Rhopalonaria pertenuis* by Ulrich, but later placed by him as a synonym of *S. proutana* Miller. Nickles and Bassler recognized James's name, but considered *S. tenuissima* of sufficient value to rank as a variety. The present study indicates that this last form has the zoëcium typical of the species and differs only in its greatly elongated stolon.

*Occurrence.*—An abundant fossil, beginning with the Stones River, in practically all of the Middle and Upper Ordovician and earliest Silurian (Richmond) formations of North America. In Europe the species is less abundantly represented, but is known from several of the Middle Ordovician formations of the Baltic provinces of Russia.

*Plesiotypes.*—Cat. nos. 13615, 43260, 43263, 54156, 54165, 54199, U.S.N.M.

**CORYNOTRYPA BARBERI, new species.**

At first sight this new species seems to be only an exceptionally large form of *C. delicatula*, but upon closer inspection other differences may be noted. These are, especially, the rapid swelling of

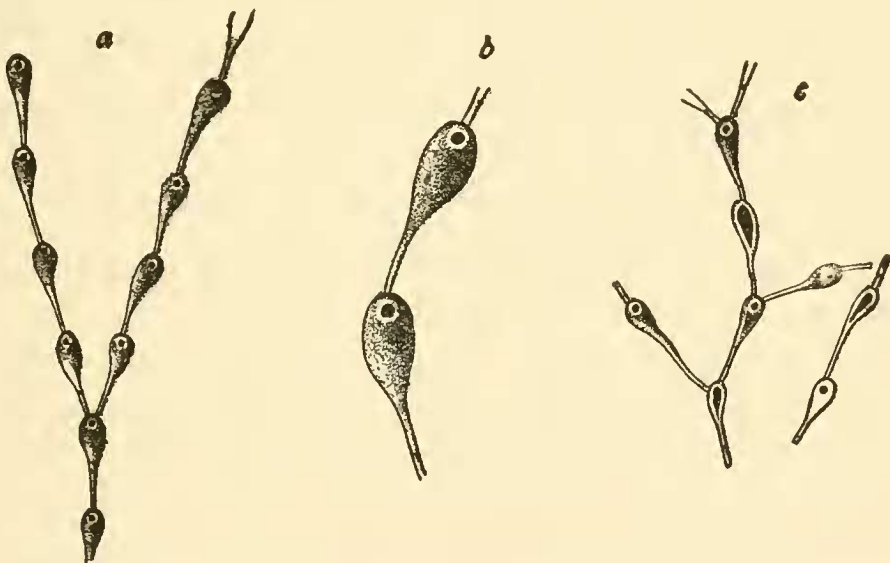


FIG. 8.—CORYNOTRYPA BARBERI. *a*, PORTION OF THE TYPE-SPECIMEN,  $\times 9$ , INCRUSTING A BIFOLIATE BRYOZOAN; *b*, SEVERAL ZOECIA,  $\times 20$ . ORDOVICIAN, OTTOSEE FORMATION, KNOXVILLE, TENNESSEE. *c*, PART OF A SMALL COLONY,  $\times 9$ , GROWING UPON A SPECIES OF HELIOLITES. EARLY SILURIAN, LYCKHOLM FORMATION, HOHENHOLM, ISLAND OF DAGO, BALTIC SEA.

the zoëcia after the stolonial portion has been left behind, and the marked difference between the stolon and the zoëcium proper. In *C. delicatula* the angle of divergence is so small ( $15^\circ$ ) and the increase in the zoëcial diameter so gradual that it is difficult to discriminate



between the stolon and the zoëcium proper. *C. barberi*, however, with equally slender and long stolons, has an angle of  $30^\circ$ , which is sufficient to cause the zoëcium to stand out prominently. Comparisons of equally magnified views of this and related species, as shown in figure 3, indicate the unusually large size of the zoëcium in *C. barberi*, although its stolon has practically the same dimensions as the more delicate forms. The dimensions of the species are as follows: An average zoëcium, including the stolon, is 1 mm. long and 0.23 mm. wide at its greatest diameter. The angle of divergence, as noted before, is  $30^\circ$ .

In growth, relative position and size of apertures, and height of peristome, *C. barberi* differs in no way from other members of the *C. delicatula* section, although, because of its large angle of divergence, it may be regarded as approaching the *C. inflata* section. The species often forms very luxuriant growths upon massive bryozoans, brachiopods, and other organisms. Such zoaria, with their prominent although delicate zoëcia, form striking cabinet specimens.

The specific name is in appreciation of the excellent collections made in the vicinity of his home city by Mr. Manly D. Barber, of Knoxville, Tennessee.

*Occurrence.*—Common in the shales of the Holston and Ottosee formations at Knoxville, Tennessee, and at many other places in that state and Virginia, where the same strata outcrop. Specimens indistinguishable from the types occur in the Lyckholm formation at Hohenholm, Island of Dago, Baltic Sea, in rocks equivalent to the Richmond group of America.

*Holotype and paratype.*—Cat. nos. 57105, 57106, U.S.N.M.

#### CORYNOTRYPA ELONGATA (Vine).

*Stomatopora dissimilis*, var. *elongata* VINE, Quart. Journ. Geol. Soc. London, vol. 38, 1882, p. 50.

*Stomatopora elongata* VINE, Ann. and Mag. Nat. Hist., ser. 5, vol. 14, 1884, p. 85, fig. IV, 2.—BASSLER, Bull. U. S. Geol. Surv., no. 292, 1906, p. 14, pl. 4, figs. 10–14.

*Stomatopora parva* RINGUEBERG, Bull. Buffalo Soc. Nat. Hist., vol. 5, 1886, p. 20, pl. 2, fig. 16.

*Original description.*—“*Stomatopora dissimilis* Vine, var. a. *elongata*. Zoarium very irregular, clustering. Zoëcia elongated, with, at times, long stoloniferous processes which intermingle with the cells. When colonial growth is distinct, arrangement of cells is linear and uniserial. Measured under favorable circumstances, about three cells occupy the space of one line.”

The present species has been treated by me at some length in the article cited above, and the following notes are mainly from that

work. The identity of the American form with Vine's species has been determined by the study of an authentic example from the original Wenlock shales material studied by Vine. A few zoecia of this example are shown in figure 9a, and comparison of this with the remaining figures of the American form indicates the specific identity. The long stoloniferous processes mentioned by Vine as intermingling with the cells are the stolons of ctenostomatous bryozoans such as *Vinella* or *Ascodictyon*, having no connection at all, of course, with *Corynotrypa*. Such widely diverse incrusting species are often found with their zoaria intermingled, but it usually requires little care to determine that one is merely growing over the other. The following description brings out the characters of *C. elongata* as observed in the present study.

Zoarium incrusting foreign objects, the smooth epitheca of corals or bryozoans being most frequently selected in the American examples. Zoecia uniserial, branching at irregular intervals, slender, fusiform, increasing slowly in size from a diameter of 0.03 mm. to 0.04 mm. at the proximal end, to one

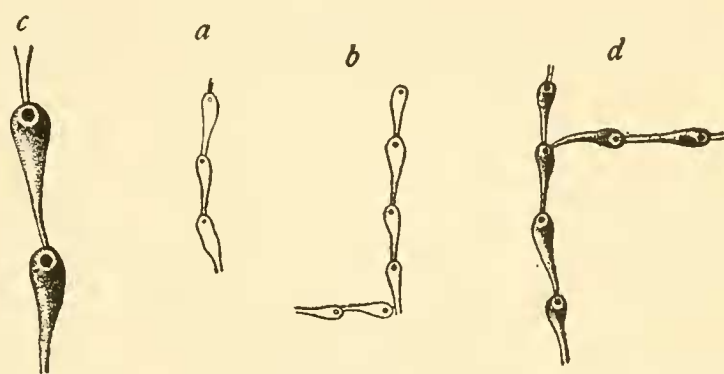


FIG. 9.—*CORYNOTRYPA ELONGATA*. *a*, SKETCH OF AN AUTHENTIC SPECIMEN,  $\times 9$ . SILURIAN (WENLOCK), ENGLAND; *b*, OUTLINE VIEW,  $\times 9$ , OF AN AMERICAN EXAMPLE INCRUSTING THE EPITHECAL SIDE OF A BRYOZOAN; *c*, TWO ZOECIA OF THE SAME,  $\times 20$ . SILURIAN, ROCHESTER SHALE, ROCHESTER, NEW YORK. *d*, PORTION OF A ZOARIUM,  $\times 12$ , INCRUSTING A BRACHIPOD. SILURIAN, WALDRON SHALES. WALDRON, INDIANA.

of 0.15 mm. to 0.18 mm. at the distal or anterior end, which, although normally rounded, is sometimes slightly drawn out. An average zoecium is 0.60 mm. in length; when arranged in a straight line, seven zoecia may be counted in the space of 4 mm.; angle of divergence about  $25^\circ$ . Aperture small, rounded, subterminal, with a slightly elevated border and less than half the greatest width of the zoecium in diameter. Surface of the zoecia smooth, probably finely porous.

*Corynotrypa elongata* is most certainly the Silurian representative of the abundant Ordovician *C. delicatula*, from which it differs mainly in its increased angle of divergence.

*Occurrence*.—Somewhat rare in the Buildwas beds of the Wenlock shales, Shropshire, England; Clinton formation, Seven Mile Creek, near Eaton, Ohio; Rochester shale, Rochester and Lockport, New York; Waldron shale, Newsom, Tennessee, and Waldron, Indiana.

*Plesiotypes*.—Cat. nos. 35475, 57107, U.S.N.M.

## CORYNOTRYPA NITIDA, new species.

This very delicate, dainty species is clearly a descendant of the Ordovician type of the genus, *C. delicatula* (James), and of the widespread Silurian form, *C. elongata* (Vine). Indeed, these three forms are so similar that it is difficult if not impossible to point out striking differences. Very conservative students would probably regard the three as merely varieties, if not the same species, but, in view of their different geologic ages, and of the fact that some differences, however slight, may be observed, it is believed that the retention of separate specific names is preferable.

The incrusting zoarium of *C. nitida* has so far been noted only on corals, the two type-specimens growing upon *Pachypora fischeri* and *Cystiphyllum americanum*, respectively. The zoecia are very slender and much elongated, the angle of divergence being about  $20^{\circ}$ . An

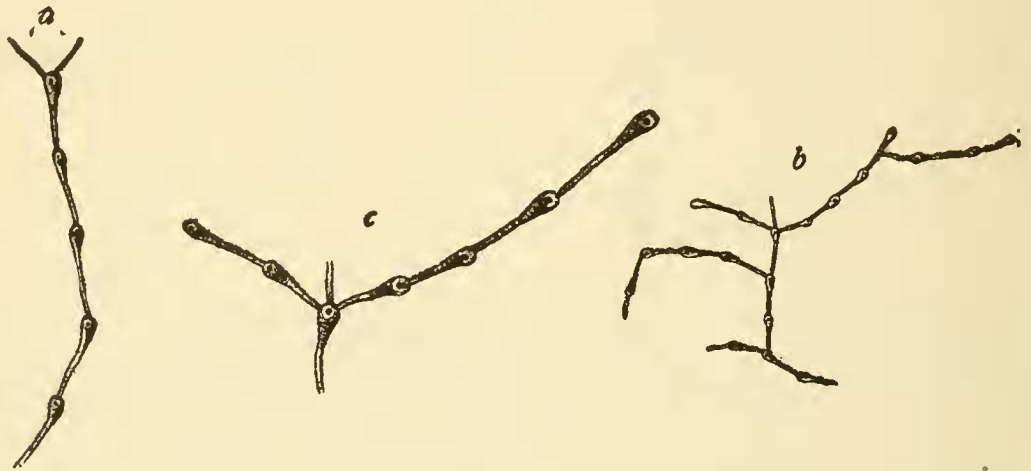


FIG. 10.—CORYNOTRYPA NITIDA. *a*, PORTION OF A ZOARIUM,  $\times 20$ , GROWING UPON THE CORAL *PACHYPORA FRONDOSA*. DEVONIAN, HAMILTON GROUP, ARKONA, ONTARIO. *b*, SKETCH OF A ZOARIUM,  $\times 9$ , INCrustING A CUP CORAL; *c*, SEVERAL ZOECIA OF THE SAME,  $\times 20$ . SAME HORIZON AT THEDFORD, ONTARIO.

average zoecium, including the stolon, is 0.5 mm. long and 0.07 mm. across at its widest part, and 6 to 7 zoecia may be counted in 3 mm. The aperture is subterminal and constricted, about one-third the diameter of the zoecium, and bears a low rim.

Compared with its Silurian progenitor, *C. elongata*, the present form is found to be decidedly smaller and more delicate and to have a less rapid angle of divergence. In general shape *C. delicatula* is probably more closely related, but here again the zoecia, although delicate, are coarser in every measurement than in *C. nitida*.

*Occurrence.*—Apparently rare in the shales of the Hamilton group at Thedford and Arkona, Canada.

*Cotypes.*—Cat. nos. 54180, 54181, U.S.N.M.



## CORYNOTRYPA TENUICHORDA (Ulrich and Bassler).

*Stomatopora tenuichorda* (*temnichorda* in error) ULRICH and BASSLER, Geol. Surv. New Jersey, Paleontology, vol. 4, 1907, p. 314, pl. 20, figs. 5, 6.

*Original description.*—"Zoarium adnate, frequently branching, consisting of uniseriably arranged zoecia. Zoecia elongate-pyriform, or club-shaped, 0.45 mm. to 0.75 mm. in length, about 0.02 mm. in width at the posterior extremity, increasing very gradually in size through about one-half their length, and then somewhat abruptly to about 0.15 mm. at the rounded anterior end. Zoecial aperture nearly terminal, small, circular, with a slightly elevated, rim-like border, from 0.035 mm. to 0.05 mm. in diameter."

This delicate species is represented in the collections of the National Museum by a number of specimens, a portion of the best preserved one of which is shown in figure 11. While the general aspect of the species is precisely the same as in others of the *C. delicatula* group, a slight constriction in the middle portion of the zoecium proper causes a noticeable swelling in its proximal portion, giving an appearance somewhat similar to that often seen in certain forms of *Hippothoa*. None of the specimens shows any other features characteristic of *Hippothoa*, and all agree with *Corynotrypa* in every respect save the one character mentioned. Until more evidence is at hand, the species may be regarded as a typical *Corynotrypa*, differing from the other narrow, elongate species in having a greater angle of divergence ( $30^\circ$ ), and in the proximal swelling of the zoecia mentioned above.

*Occurrence.*—Not uncommon in the Vincentown sand of the Cretaceous, at Vincentown, New Jersey.

*Holotype.*—Cat. no. 52618, U.S.N.M.

## CORYNOTRYPA INFLATA SECTION.

The angle of divergence obtaining in species assigned to the *C. delicatula* section is usually so small that the stolon and the expanded part of the zoecium blend together to produce a structure which varies only in length. The variability in this section, therefore, although just as great, is not so conspicuous as in the *C. inflata*

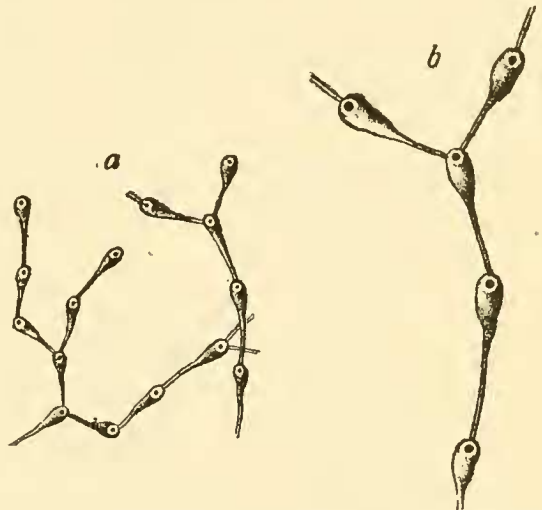


FIG. 11.—CORYNOTRYPA TENUICHORDA. a, PORTION OF A WELL PRESERVED ZOARIUM,  $\times 9$ , INCRUSTING THE INTERIOR OF A PELECYPOD; b, ZOECIA OF THE SAME ZOARIUM,  $\times 20$ . CRETACEOUS, VINCENTOWN SAND, VINCENTOWN, NEW JERSEY.

section, where a wider angle of divergence results in a more expanded zoecium, contrasting sharply with the narrow, tubular stolon.

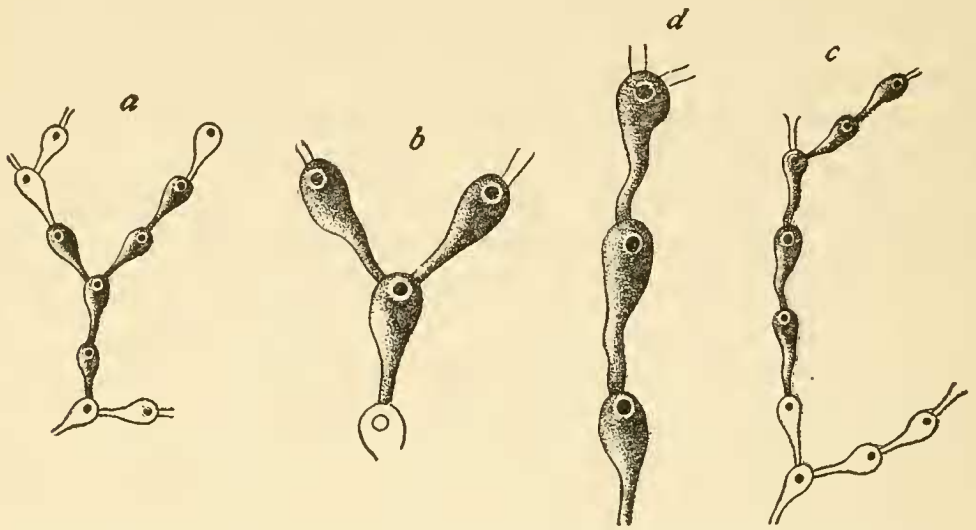


FIG. 12.—*CORYNOTRYPA INFLATA*, ILLUSTRATING DEVELOPMENT OF UNUSUALLY LONG STOLONS. *a* AND *b*, PORTIONS OF A ZOARIUM,  $\times 9$  AND  $\times 20$ , INCrustING THE BRACHIOPOD *RAFINESQUINA SQUAMULA*. ORDOVICIAN, ECONOMY BEDS OF EDEN FORMATION, FORT THOMAS, KENTUCKY. *c* AND *d*, ANOTHER ZOARIUM,  $\times 9$  AND  $\times 20$ , INCrustING A RAMOSE BRYOZOAN. SAME HORIZON AT WEST COVINGTON KENTUCKY.

Comparing the normal examples of *C. inflata*, for instance, as shown in figure 15, with specimens of the same species possessing elongated

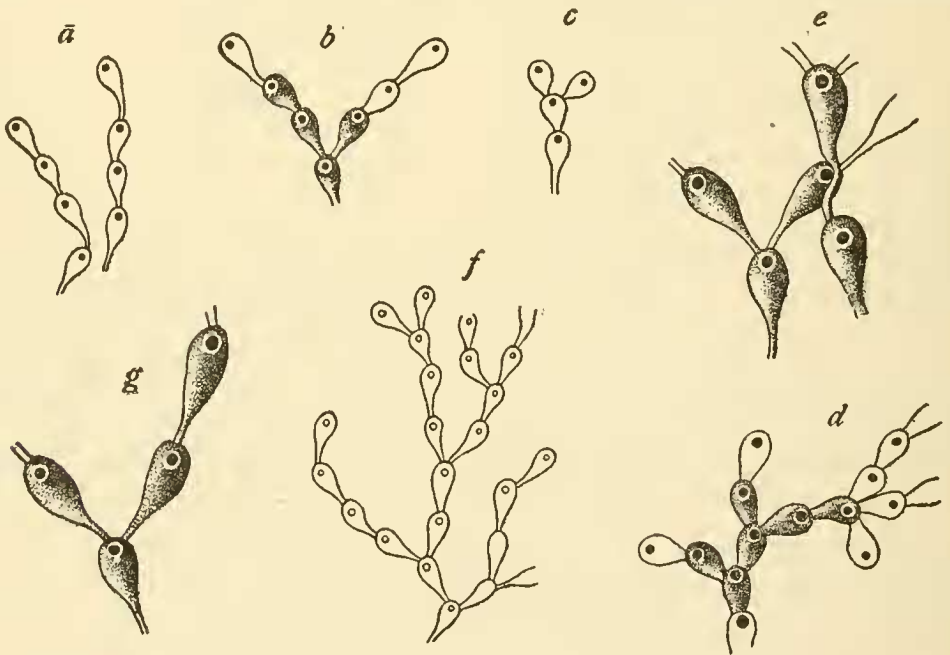


FIG. 13.—*CORYNOTRYPA INFLATA*, ILLUSTRATING VARIABLE LENGTH OF STOLONS. *a*, *b*, AND *c*, THREE PORTIONS OF THE SAME ZOARIUM,  $\times 9$ , INCrustING THE PEDICLE VALVE OF *STROPHOMENA TRENTONENSIS*. ORDOVICIAN, TRENTON FORMATION, ZYGOSPIRA BEDS, ST. PAUL, MINNESOTA. *d*, ANOTHER ZOARIUM,  $\times 9$ , WITH UNUSUALLY SHORT STOLONS, BLACK RIVER GROUP, PHYLLOPORINA BED, NEAR CANNON FALLS, MINNESOTA. *e*, ZOECIA,  $\times 20$ , WITH UNUSUALLY LONG STOLONS, GROWING UPON A FRAGMENT OF A TRILOBITE. ECONOMY BEDS OF EDEN FORMATION, NEWPORT, KENTUCKY. *f* AND *g*, A ZOARIUM,  $\times 9$ , AND A PORTION,  $\times 20$ , INCrustING *RAFINESQUINA ALTERNATA*. UPPER BEDS OF THE EDEN FORMATION, CINCINNATI, OHIO.

stolons (fig. 12), one might, without a study of this individual variation, refer the two sets to separate species. In the typical forms of

*C. inflata*, the stolon is quite short, in fact, often practically absent. The numerous examples before me show that this condition may prevail as long as the surface incrustated by the delicate zoaria is fairly even and smooth. Such a surface is afforded by the brachiopods incrustated by the originals of figure 15. The coarse striations of the brachiopod *Rafinesquina squamula*, incrustated by the originals of figs. 12*a*, *b*, produce a more uneven surface, and a similar surface is caused by the zoecial apertures and acanthopores of the ramose bryozoan bearing the zoarium figured in 12*c*, *d*. The effect upon the length of the stolon is shown in the illustrations.

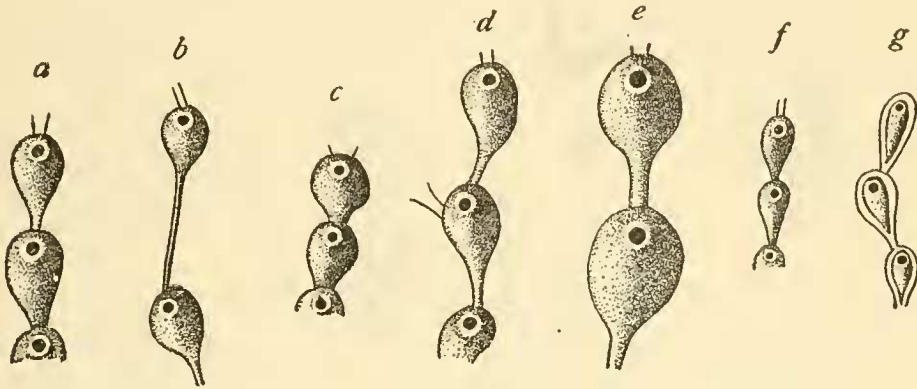


FIG. 14.—CORYNOTRYPA INFLATA SECTION. A GROUP OF ZOECIA, ALL  $\times 20$ , EXCEPT POSSIBLY *g*, SHOWING SPECIFIC DIFFERENCES. *a*, CORYNOTRYPA INFLATA; *b*, *C. ABRUPTA*; *c*, *C. CURTA*; *d*, *C. MEDIALIS*; *e*, *C. TURGHIDA*; *f*, *C. DEVONICA*; *g*, *C. SMITHI*.

In each of the examples compared above, either long or short stolons have been uniformly developed in the portions used for illustration. Such uniformity is not the rule, however, for both extremes and all intermediate lengths may be found in the same zoarium. This is shown in a zoarium incrusting a pedicle valve of *Strophomena trentonensis*, portions of which are smooth and other parts rough (figs. 13*a-c*). In another colony (fig. 13*d*), incrusting the nearly smooth base of a *Prasopora*, the stolon is wanting practically throughout the entire growth. Figure 13*e* illustrates the length of stolon attained when one zoecium grows over another. Another zoarium bearing zoecia with stolons of variable length is illustrated in figures 13*f* and *g*.

Normal zoecia of each of the species referred to the *C. inflata* section of *Corynotrype* have been assembled in figure 14.

#### CORYNOTRYPA INFLATA (Hall).

*Alecto inflata* HALL, Nat. Hist. New York, Pal., vol. 1, 1847, p. 77, pl. 26, figs. 7*a*, *b*.

*Hippothoa inflata* NICHOLSON, Pal. Ohio, vol. 2, 1875, p. 268, pl. 25, figs. 1-1*b*.

*Stomatopora inflata* VINE, Quar. Journ. Geol. Soc. London, vol. 37, 1881, p. 615.—

ULRICH Journ. Cincinnati Soc. Nat. Hist., vol. 12, 1890, p. 176, fig. 3*c*; Geol. and Nat. Hist. Surv. Minnesota, Final Rep., vol. 3, pt. 1, 1893, p. 117, pl. 1, figs. 13-21; Zittel's Textb. Pal. (Eng. ed.), p. 261, fig. 412*B*.—SIMPSON, Fourteenth Ann. Rep. State Geol. New York for the year 1894, 1897, p. 597, figs. 202-204.—RUEDEMANN, Bull. New York State Mus., no. 49, 1901 [1902], p. 12, pl. 1, figs. 2, 3.—CUMINGS, Thirty-second Ann. Rep. Dep. Geol. Nat. Res. Indiana, 1907, p. 886, pl. 32, figs. 1, 1*a*



*Zorium* adnate, usually upon ramose or solid bryozoans or brachiopods; zoëcia typically short, pyriform, with the stolon but slightly developed; eight or nine zoëcia in 5 mm.; angle of divergence averaging  $40^\circ$ . Exclusive of the stolon a single specimen is 0.4 mm. long and 0.26 mm. wide. The aperture has a distinct peristome, is direct, circular, about 0.09 mm. in diameter, and situated near the anterior end.

The variability of this species has been noted in the previous remarks upon the section. Reference to the illustrations (figs. 12

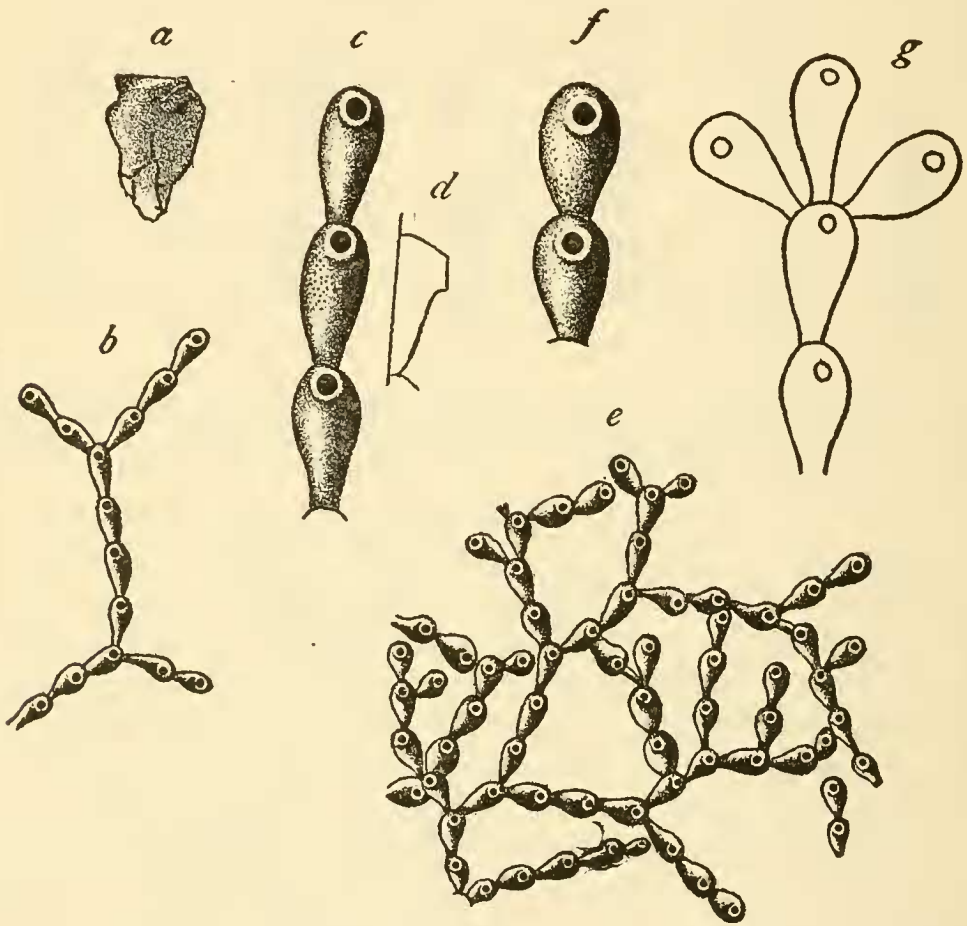


FIG. 15.—*CORYNOTRYPA INFLATA*. *a* and *b*, ZOARIUM NATURAL SIZE, AND A PORTION,  $\times 9$ ; *c*, THREE ZOECIA OF SAME,  $\times 18$ , SHOWING THE POROUS WALL; *d*, A VERTICAL SECTION OF A ZOECIUM,  $\times 18$ . UPPER THIRD OF THE TRENTON SHALES AT CANNON FALLS, MINNESOTA. *e* and *f*, SMALL PORTION OF A COLONY INCRUSTING *RAFINESQUINA ALTERNATA*,  $\times 9$  AND  $\times 18$ ; *g*, OUTLINE OF ZOECIA,  $\times 18$ , SHOWING THREE "GEMS" SPRINGING FROM ONE PARENT CELL. CORRYVILLE BEDS OF McMILLAN FORMATION, CINCINNATI, OHIO. (AFTER ULRICH.)

and 13) will show that the zoëcia of such variable zoaria are normal if the stolon is eliminated.

The pyriform shape and the size of the zoarium combined with its rather considerable angle of divergence, will distinguish *C. inflata* from related members of the section. The Devonian and Jurassic species, *C. devonica* and *C. smithi*, have a very similar zoarium, but in each instance their zoëcia, so far as present knowledge goes, are much smaller. The other members of the *C. inflata* section have

greater angles of divergence and their zoëcia are therefore correspondingly more swollen.

*Occurrence.*—Specimens of *C. inflata* are generally abundant in all of the middle and upper Ordovician and earliest Silurian (Richmond) formations of North America. Recently its geographic range has been extended by the discovery of typical examples in the middle Ordovician (Wesenberg) limestone, at Wesenberg, Esthonia, Russia. The original types came from the Trenton rocks of New York, where the zoarium is of more delicate growth than in the higher formations. The forms from the several Cincinnati formations have a very luxuriant growth, one network of zoëcia covering another until dense clusters result.

*Plesiotypes.*—Cat. nos. 43261, 43262, 54146, 54149, 54162, 54169, 54202, 57108, U.S.N.M.

**CORYNOTRYPA ABRUPTA**, new species.

Zoarium adnate, consisting of frequently branching, elongated, rather large, clavate zoëcia, much swollen at the anterior end. The

tubular proximal stolonial portion is almost thread-like, being not more than 0.04 mm. in width. This diameter is retained until the anterior third or fourth is reached, when the zoëcium abruptly swells, with an angle of divergence of  $50^\circ$ , and becomes rounded, with a diameter of 0.20 to

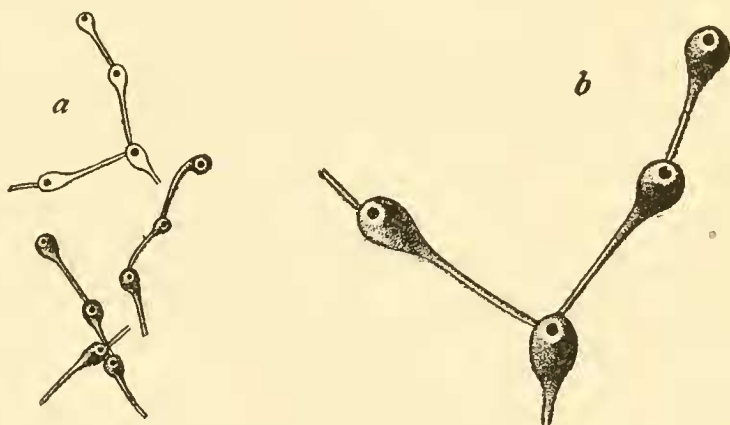


FIG. 16.—*CORYNOTRYPA ABRUPTA*. *a* AND *b*, PORTIONS OF THE TYPE-SPECIMEN,  $\times 9$  AND  $\times 20$ , INCRUSTING A FRAGMENT OF *RHYNCHOTREMA CAPAX*. RICHMOND GROUP, IRON RIDGE, WISCONSIN.

0.25 mm. An average zoëcium and its stolon is 1.0 mm. long, but in individual zoëcia of the same zoarium the thread-like proximal portion may range in length from less than 0.10 mm. to 1 mm. The swollen anterior zoëcial portion, however, is fairly constant in its measurements, as no deviation from a width ranging between 0.20 mm. and 0.25 mm., and a length of 0.32 mm. to 0.40 mm. has been observed. The apertures are round, subterminal, bordered by a slightly elevated rim, and small, averaging only about 0.09 mm. in diameter.

*Corynotrypa abrupta* is easily distinguished from all other species of the genus by the extremely narrow proximal portion and the very abrupt swelling of the anterior end of the zoëcium. In related species such as *C. inflata* (Hall) and *C. medialis*, new species, the change from the proximal to the anterior end is less abrupt, but in

the present form the two portions are most distinctly marked. The extreme variation in the length of the narrow proximal portion is noted above, and is indicative of the fact that this part of the zoecium is the least stable in simple species of Cyclostomata.

*Occurrence.*—The American specimen illustrated in figure 16, upon which the species is based, incrusts a fragment of *Rhynchotrema capax* and was found in the highest beds of the Maquoketa shale division of the Richmond group at Iron Ridge, Wisconsin. The Russian example assigned to the species (fig. 17) was found at Kertel, Island of Dago, in the Lyckholm limestone, associated with *Calapoecia cribriformis* Nicholson,

*Halysites* sp., *Streptelasma*, and other fossils known to occur in certain strata of the Richmond group in America.

*Holotype* and *paratype.*—Cat. nos. 54173, 57109, U.S.N.M.

CORYNOTRYPA CURTA, new species.

This rather unique species grows usually in crowded little masses of zoecia, which, at first glance, show slight resemblance to the

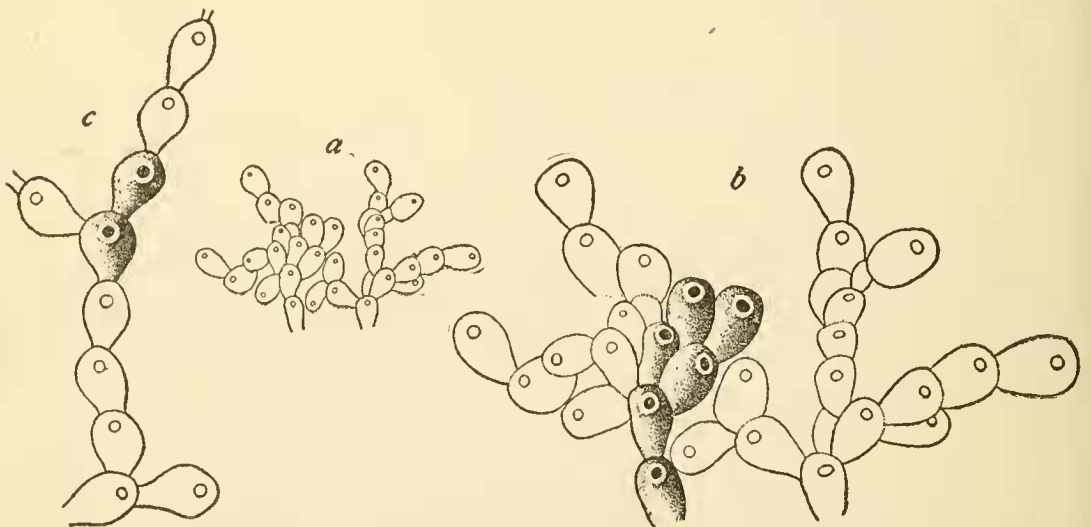


FIG. 17.—CORYNOTRYPA ABRUPTA. *a* AND *b*, PORTION OF A ZOARIUM,  $\times 9$  AND  $\times 20$ , INCRUSTING A CRINOID COLUMN. EARLY SILURIAN, LYCKHOLM FORMATION, KERTEL, ISLAND OF DAGO, BALTIC SEA.

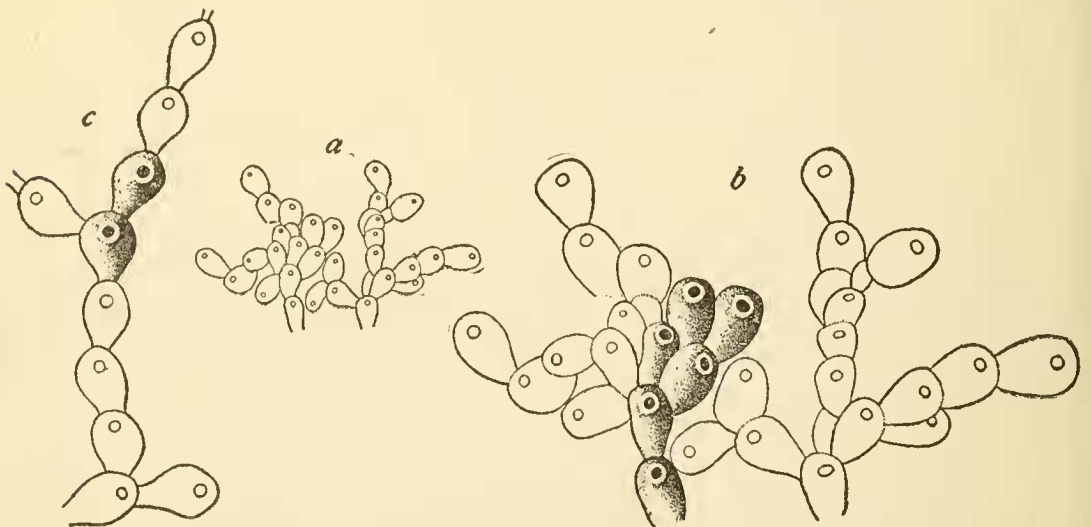


FIG. 18.—CORYNOTRYPA CURTA. *a* AND *b*, PORTION OF A CROWDED ZOARIUM,  $\times 9$  AND  $\times 20$ , INCRUSTING THE BRYOZOAN *LIOCLEMELLA SOLIDISSIMA*; *c*, FRAGMENT OF A ZOARIUM GROWING MORE NORMALLY,  $\times 20$ . RICHMOND GROUP, SAVANNAH, ILLINOIS.

delicate, graceful colonies of other members of the genus. Upon resolving these small zoaria into their component zoecia, it becomes



evident that the crowded effect is produced by frequent budding of the short, almost rounded cells. A portion of such a dense growth is illustrated in figures 18*a*, *b*. Occasionally specimens with simple strings of zoëcia are found, and these show the intimate relationship of *C. curta* to the more common *C. inflata*.

Further comparisons with *C. inflata* will show the following differences: In *C. curta* the stolon is practically entirely absent, the zoëcium is small, but its angle of divergence is so great ( $70^\circ$ ) that the outline is subcircular or broadly oval. *C. inflata* has a larger and more pyriform zoëcium, a distinct although short stolon, and a much smaller angle of divergence ( $40^\circ$ ). The other species of the genus are less closely related and will not need detailed comparison.

The measurements of a normal zoëcium in *C. curta* are: Length, 0.33 mm.; greatest width, 0.26 mm.; angle of divergence,  $70^\circ$ ; six zoëcia in 2 mm.

*Occurrence*.—Not uncommon in the upper beds of the Maquoketa shale division of the Richmond group at Savannah, Illinois.

*Cotypes*.—Cat. no. 54171, U.S.N.M.

CORYNOTRYPA MEDIALIS, new species.

The specimens upon which this species is based occur in the Richmond formation, associated with typical examples of *Corynotrypa turgida* and *C. inflata*. This association, in connection with the fact that the characters of *C. medialis* are intermediate between the other two forms, might give rise to the idea that the three are merely mutations of a single species. Such an idea is disproved, first by the constancy in the size of the zoëcium proper in each species, and second by the practical identity of the angle of divergence in separate individuals of the same species. The zoëcium of *C. turgida* is so much larger than that of *C. inflata* that one of intermediate size is still distinct enough to be easily recognized as different from each with even a low power hand lens. Normal zoëcia of these three species are contrasted in figure 14, while a portion of the specimen selected as the holotype is figured above. The variable length of the stolon is shown in figure 19*a*, although a greater variation may be expected on other examples.

The dimensions of the usual zoëcium of *C. medialis* are as follows: Length of expanded portion, 0.50 mm.; greatest width, 0.26 mm.;

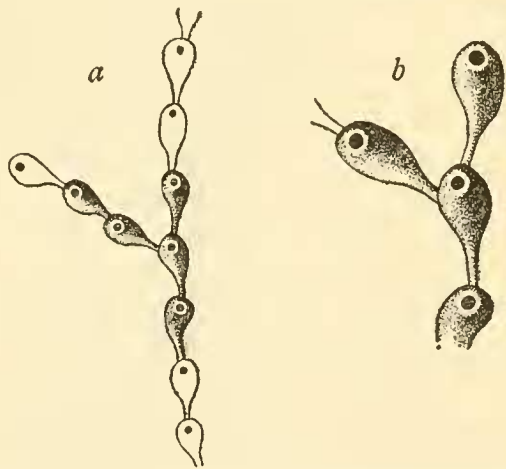


FIG. 19.—CORYNOTRYPA MEDIALIS. *a*, A PART OF THE TYPE-SPECIMEN,  $\times 9$ , INCRUSTING A CYSTID PLATE; *b*, SEVERAL ZOËCIA OF SAME,  $\times 20$ . RICHMOND GROUP, THREE MILES NORTH OF SPRING VALLEY, MINNESOTA.

average length of stolon, 0.17 mm.; four to four and one-half zoëcia in 3 mm.; angle of divergence about  $50^{\circ}$ .

*Occurrence.*—Apparently rare in the Richmond group, 3 miles north of Spring Valley, Minnesota.

*Holotype.*—Cat. no. 57110, U.S.N.M.

CORYNOTRYPA TURGIDA (Ulrich).

*Stomatopora turgida* ULRICH, Journ. Cincinnati Soc. Nat. Hist., vol. 12, 1890, p. 176, fig. 3; Geol. and Nat. Hist. Surv. Minnesota, Final Rep., vol. 3, pt. 1, 1893, p. 118, pl. 1, figs. 22, 23.

*Original description.*—“Zoarium adnate, consisting of a single branching series of zoëcia. Zoëcia comparatively very large, the

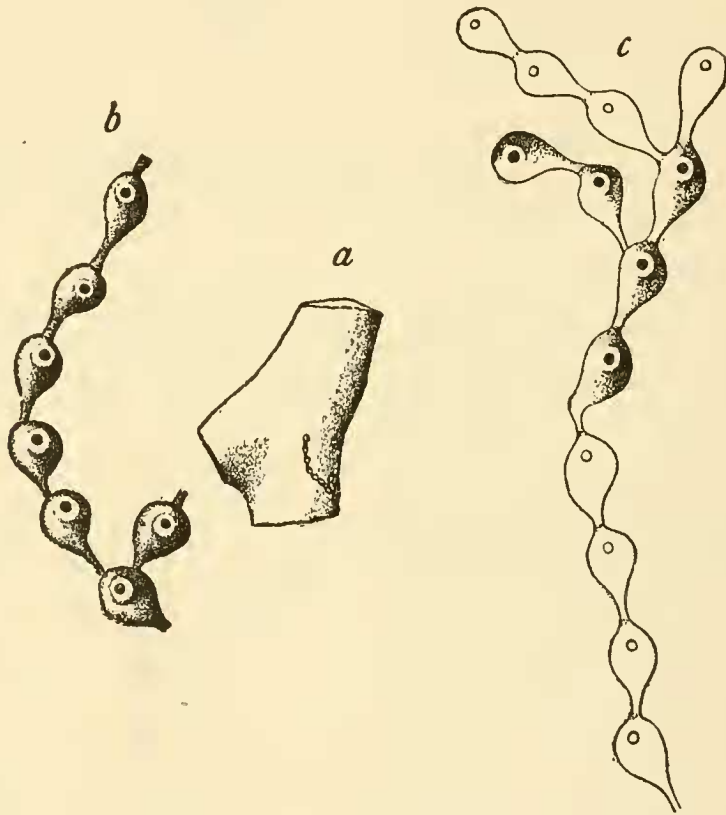


FIG. 20.—CORYNOTRYPA TURGIDA. *a* AND *b*, THE TYPE-SPECIMEN, NATURAL SIZE AND  $\times 9$ . RICHMOND GROUP (FERNVALE FORMATION), WILMINGTON, ILLINOIS. (AFTER ULRICH.) *c*, A SPECIMEN,  $\times 9$ , FROM THE RICHMOND GROUP, 3 MILES NORTH OF SPRING VALLEY, MINNESOTA.

anterior half much swollen, rapidly tapering posteriorly, with the slender, tubular proximal end inserted beneath the turgid anterior end of the preceding zoëcium. Five zoëcia in 5 mm.; length of each zoëcium varying from 0.85 to 1.30 mm.; the greatest diameter of the anterior half from 0.4 to 0.6 mm. The longest cells are the least turgid, while the shortest are the most. Apertures round, bordered by an elevated margin, small, 0.1 mm. in diameter, and situated about one-fourth of the length of the zoëcium from its anterior end.”

This species is represented in the collections of the U. S. National Museum by two excellent specimens from the type-locality, and by a third form from Minnesota, all of which agree with the description and measurements given above. The exceptionally large swelling of the zoëcia, and the very short and narrow stolonal portion are in such contrast that little difficulty should be experienced in recognizing the species. The amount of divergence of the zoëcium proper is about  $50^\circ$ . A similar abrupt swelling of the same region is present in *C. curta* and *C. abrupta* from the Richmond group, but each of these has zoëcia only one-third the size of those of *C. turgida*.

*Occurrence*.—Rare in the Richmond group (Fernvale shale) at Wilmington, Illinois, and in the same group at a locality 3 miles north of Spring Valley, Minnesota.

*Plesiotype*.—Cat. no. 54155, U.S.N.M.

CORYNOTRYPA DEVONICA (Oehlert).

*Hippothoa devonica* OEHLERT, Bull. Soc. d'Etudes Scientifiques d'Angers, vol. 17, 1888, p. 104, pl. 10, figs. 2-2c.

This species is known to me only from Oehlert's illustrations, which are here reproduced. Judging from these figures and from the magnifications ascribed to them, *C. devonica* belongs to the *C. inflata* section of *Corynotrypa*, but differs in its conspicuously smaller size. *C. inflata* has eight or more zoëcia in 5 mm., while fourteen to fifteen occur in the same diameter in *C. devonica*. It is probable that more careful study and illustrations of Oehlert's species will reveal other differences, although present knowledge is sufficient to place the form generically and to point out its specific relationships.

*Occurrence*.—Devonian, La Baconniere, Department de la Mayenne, France.

CORYNOTRYPA SMITHI (Phillips).

*Cellaria smithi* PHILLIPS, Geol. Yorkshire, pt. 1, Yorkshire Coast, 1829, p. 143, pl. 7, fig. 8.—BEAN, Mag. Nat. Hist., ser. 2, vol. 3, 1839, p. 58.—WRIGHT, Quart. Journ. Geol. Soc. London, vol. 16, 1860, p. 28.

*Hippothoa smithi* MORRIS, Cat. Brit. Foss., 1843, p. 39; ed. 2, 1854, p. 125.—HAIME, Mem. Soc. Geol. France, ser. 2, vol. 5, 1854, p. 217.—PICTET, Traite Pal., ed. 2, vol. 4, 1857, p. 103.

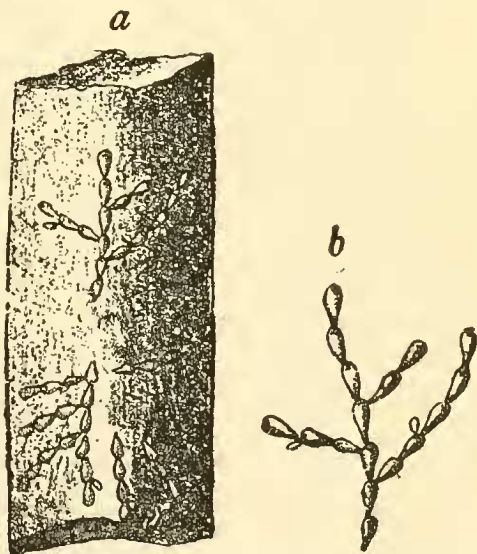


FIG. 21.—CORYNOTRYPA DEVONICA. *a*, ONE OF THE TYPE-SPECIMENS,  $\times 7$ ; *b*, PORTION OF THE SAME,  $\times 12$ . DEVONIAN, DEPARTMENT DE LA MAYENNE, FRANCE. (AFTER OEHLERT.)



*Alecto smithi* D'ORBIGNY, Prodr. Pal., vol. 1, 1849, p. 317.

*Stomatopora smithi* GREGORY, Rep. Yorkshire Philos. Soc., 1894, p. 58, fig. 1; Ann. and Mag. Nat. Hist., ser. 6, vol. 15, 1895, p. 226; Cat. Foss. Bryozoa, The Jurassic Bryozoa, 1896, p. 56, fig. 8.

Gregory's description of this species follows:

Zoarium hippothoiform, uniserial; branches crowded and irregular; entirely adherent.

Zoecia pyriform; long, slender, proximal ends; front wall well raised, rounded, and punctate; orifice small, circular, surrounded by a low rim.

Peristomes slightly raised. Flat, regular rims surround each of the zoecia.

On account of the imperfection of Phillips's figures this species was not understood until Gregory described and refigured the type-specimen. As remarked by this author, the front walls of many zoecia in this specimen are often broken away, giving it a schizoporellidan aspect. Gregory, however, fails to mention a most

important matter, namely, the magnification of his figure. Judging from other magnifications in his volume, the figure, which is herewith reproduced, is enlarged about 25 diameters, but until this point is accurately determined the species can not be considered as fully described. *Stomatopora smithi* is undoubtedly a member of *Corynotrypa*, and, judging from its angle of divergence ( $40^\circ$ ), is quite similar to the Ordovician *C. inflata* (Hall). Gregory has given its formula as  $p, c, l, r = 1, 3, 2, 0$ , but from the variation noted in other species, more numerous specimens of *C. smithi* would show only the first and fourth terms to remain constant.

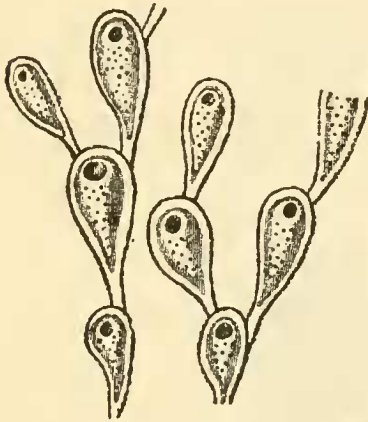


FIG. 22.—CORYNOTRYPA SMITHI. PART OF THE TYPE-SPECIMEN, INCRUSTING A CARDIUM. JURASSIC, BATHONIAN, NEAR SCARBOROUGH, ENGLAND. (AFTER GREGORY.)

*Occurrence.*—The type-specimen is incrusting *Cardium citrinoidum* and was found in the Bathonian (Cornbrash) division of the Jurassic, near Scarborough, England.

#### CORYNOTRYPA DISSIMILIS SECTION.

The four species assigned to this section form a less natural assemblage than those of the other two sections for the reason that they are either intermediate, in some of their characters, between *Corynotrypa* and *Stomatopora*, or show relationship to the other sections of *Corynotrypa*. The species selected as typical for the section has well-marked characters which are shared by only one other species, *C. tennesseensis*. These two forms constitute a small subsection characterized (1) by a slight proximal constriction of the zoecium, giving a small angle of divergence, and (2) by an aperture which, in addition

to being practically unconstricted, as in *Stomatopora*, tends also to be exsert, as in that genus. The proximal constriction of the zoecium, although slight, allies the species to *Corynotrypa*, but the remaining characters are the same as in *Stomatopora*. The two remaining species of the section, *C. schucherti* and *C. canadensis*, are more nearly related to *Corynotrypa*, since they have more constricted apertures surrounded by a peristome. Their proximal constriction, however, is much as in *C. dissimilis*, so that they must be considered as intermediate forms.

CORYNOTRYPA DISSIMILIS (Vine).

*Stomatopora dissimilis* VINE, Quart. Journ. Geol. Soc. London, vol. 37, 1881, pp. 615, 616, figs. 1-8; vol. 38, 1882, p. 50.—BASSLER, Bull. U. S. Geol. Surv., no. 292, 1906, p. 15, pl. 4, figs. 15-19.

*Stomatopora recta* RINGUEBERG, Bull. Buffalo Soc. Nat Hist., vol. 5, 1886, p. 20, pl. 2, figs. 15, 15a.

*Stomatopora minor* HENNIG, Arkiv für Zool., Kong. Sven. Vet.-Akad. Stockholm, vol. 3, no. 10, 1906, p. 24, pl. 3, fig. 6.

*Aulopora*, species, HALL, Nat. Hist. New York, Pal., vol. 2, 1852, pl. 50, figs. 27, 29.

*Original description.*—"Zoarium adnate, branching, generally attached to stems of Crinoidea, very rarely to broken shells; branches

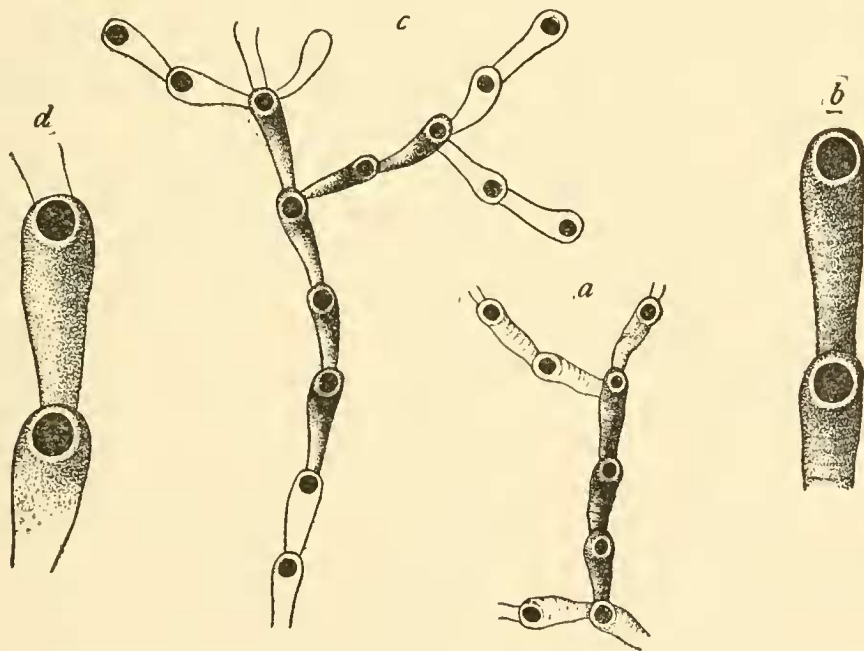


FIG. 23.—CORYNOTRYPA DISSIMILIS. *a* AND *b*, A TYPICAL EXAMPLE OF THE SPECIES,  $\times 9$  AND  $\times 20$ , INCRUSTING THE EPITHECA OF THE BRYOZOAN DIPLOTRYPA NUMMIFORMIS. SILURIAN, ROCHESTER SHALE, LOCKPORT, NEW YORK. *c* AND *d*, A POORLY PRESERVED SPECIMEN OF THE SPECIES,  $\times 9$  AND  $\times 20$ , GROWING UPON A SPECIMEN OF HELIOLITES. EARLY SILURIAN, LYCKHOLM FORMATION, KERTEL, ISLAND OF DAGO, BALTIC SEA.

linear, sometimes wavy and anastomosing. Zoecia invariably uniserial, and, in the best preserved, very finely ribbed transversely; the oral extremity slightly raised; orifice circular or subcircular. Oöcial cells rather ventricose and strongly ribbed (?). Each normal zoecium about half a line; average about 6 to  $3\frac{1}{2}$  lines."

A series of specimens from the Silurian rocks of various localities in Europe and America shows that the Wenlock shales species described by Vine as *Stomatopora dissimilis* has as wide a geographic distribution as certain Ordovician species of *Corynotrypa*. As indicated in the above synonymy, the American form was figured by Hall in 1852 without a specific designation, and later was figured and described by Ringueberg as *Stomatopora recta*.

The zoarium of *C. dissimilis* is parasitic, other bryozoans, brachiopods, and crinoid columns or plates being usually selected; uniserial, with lateral series branching usually irregularly, but sometimes very regularly and at right angles to the main series, as shown in figure 24. Zoecia subcylindrical rather than club-shaped, about 0.10 mm. in diameter at the proximal end and increasing to 0.35 mm. at the rounded distal portion; an average zoecium is 1.15 mm. in length. Apertures large, subterminal, slightly exsert. Zoecia marked transversely by fine wrinkles or striations.

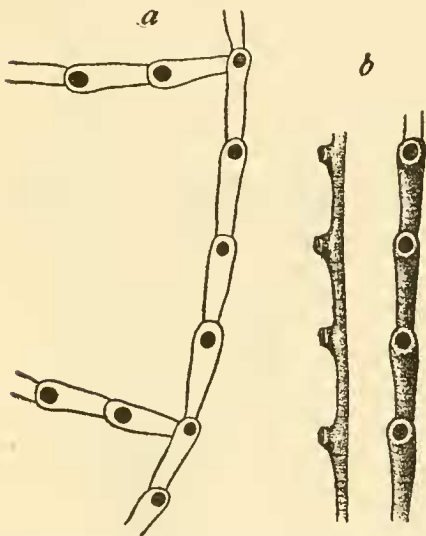


FIG. 24.—*CORYNOTRYPA DISSIMILIS*. *a* AND *b*, PORTIONS OF A ZOARIUM,  $\times 9$ , PARASITIC UPON A FRAGMENT OF A *SPIRIFER*. SILURIAN, ROCHESTER SHALE, LOCKPORT, NEW YORK. THIS SPECIMEN ILLUSTRATES BRANCHING AT RIGHT ANGLES.

(see figs. 23*c* and *d*) differ only in lacking the transversely wrinkled surface, a condition due probably to their somewhat imperfect preservation. The types are from the Buildwas beds of the Wenlock shales, Shropshire, England. The species occurs also in the Silurian beds, Island of Gotland, where it has been given the name *Stomatopora minor* by Hennig. It is abundant in the Rochester shale at Lockport and other localities in western New York, and at Grimsby, Ontario, and in the Osgood beds at Osgood, Indiana.

*Plesiotypes*.—Cat. nos. 35473, 57112, U.S.N.M.

***CORYNOTRYPA TENNESSEENSIS*, new species.**

The two well-preserved specimens upon which this new species is based present a combination of characters so similar to those of *C. dissimilis* that the same description, with slight emendations, will

The large zoecia with their transverse striations or wrinkles particularly characterize *C. dissimilis* and serve to distinguish it from all other Paleozoic species of the genus. The relations of the species to *Stomatopora* have been discussed in the remarks upon the *C. dissimilis* section (p. 522).

*Occurrence*.—The earliest appearance of *C. dissimilis* is in the Lyckholm limestone of Baltic Russia, in strata equivalent to the Richmond group of America. These specimens



apply to both. The characters in common are (1) rather large zoecia with a slight angle of divergence and transversely lined or wrinkled walls, and (2) zoecial apertures exert as in *Stomatopora* and much larger than in typical *Corynotrypa*. Comparing the two closely, the average zoecium of *C. tennesseensis* has a length of 0.75 mm. and a width of 0.30 mm. at its greatest diameter, and is therefore of less size than that obtaining in *C. dissimilis*.

The proximal constriction is also more pronounced in the older species, so that altogether it may be considered as representing an intermediate stage between the typical sections of *Corynotrypa* and the divergent group typified by *C. dissimilis*.

*Occurrence*.—Pierce limestone division of the Stones River group, 1½ miles south of Murfreesboro, Tennessee.

*Cotypes*.—Cat. no. 54177, U.S.N.M.

**CORYNOTRYPA SCHUCHERTI, new species.**

Zoarium frequently branching, uniserial, incrusting, in the case of the type-specimen, an example of *Streptelasma*. Zoecium compara-

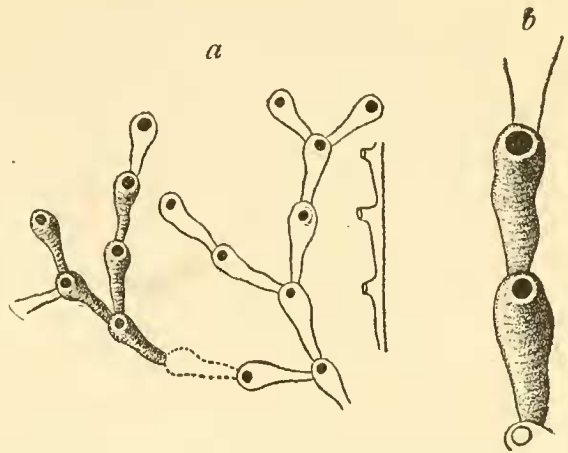


FIG. 25.—CORYNOTRYPA TENNESSEENSIS. *a*, THE TYPE-SPECIMEN,  $\times 9$ , WITH A LONGITUDINAL SECTION OF SEVERAL ZOECIA; *b*, SEVERAL ZOECIA,  $\times 20$ , INCrustING A FRAGMENT OF A STROPHOMENA. ORDOVICIAN, STONES RIVER GROUP, PIERCE LIMESTONE, ONE-HALF MILE SOUTH OF MURFREESBORO, TENNESSEE.

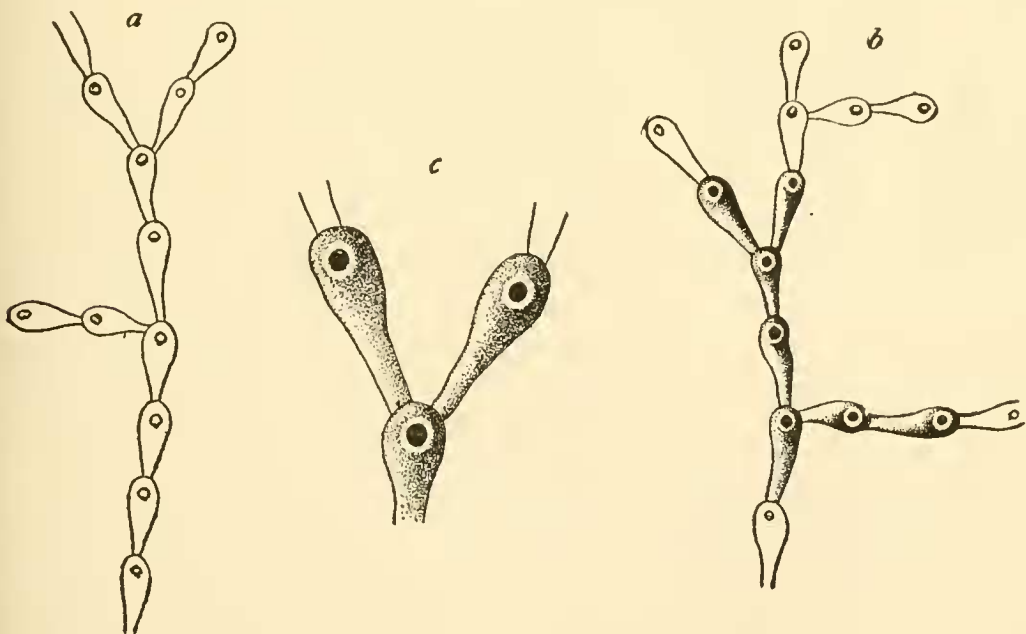


FIG. 26.—CORYNOTRYPA SCHUCHERTI. *a* AND *b*, PORTIONS OF THE TYPE-SPECIMEN, INCrustING A STREPTELASMA,  $\times 9$ ; *c*, SEVERAL ZOECIA OF THE SAME,  $\times 20$ . MIDDLE ORDOVICIAN, WESENBERG FORMATION, WESENBERG, ESTHONIA, RUSSIA.

tively large, averaging 1 mm. in length, irregularly club-shaped, the anterior half swollen, with a maximum diameter of 0.40 mm., tapering gradually in the posterior half to the narrowest part with a width of 0.15 mm., where it joins the distal end of the preceding one. Apertures subterminal, surrounded by a slight border, and with a diameter slightly more than one-third that of the zoëcium.

This species, which is named in honor of Prof. Charles Schuchert, who collected the type-specimen, is related most closely to the common American form *C. inflata*, but differs conspicuously, however, in having larger, less regular, more elongate and less rapidly tapering zoëcia. From other members of the *C. dissimilis* group it is distinguished by its constricted aperture.

*Occurrence*.—Rare in the Wesenberg limestone at Wesenberg, Esthonia, Russia.

*Holotype*.—Cat. no. 57111, U.S.N.M.

CORYNOTRYPA CANADENSIS (Whiteaves).

*Stomatopora canadensis* WHITEAVES, Pal. Foss., vol. 3, 1897, p. 161, pl. 18, figs. 4, 4a.

Through the courtesy of the Director of the Geological Survey of Canada, I am able to refigure the type of this species, which was well

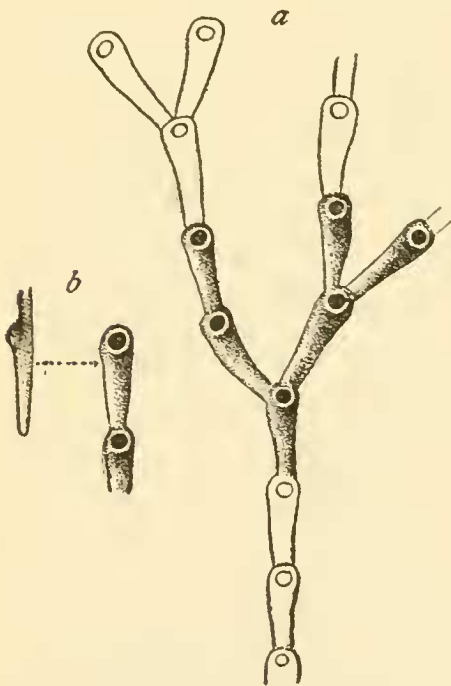


FIG. 27.—CORYNOTRYPA CANADENSIS. *a*, PORTION OF TYPE-SPECIMEN,  $\times 9$ ; *b*, FRONT AND SIDE VIEWS OF A ZOËCIUM,  $\times 9$ . MIDDLE ORDOVICIAN, SWAMPY ISLAND, LAKE WINNIPEG, CANADA.

described by Professor Whiteaves, although his illustrations are inadequate for careful discrimination. Comparing figure 27 with figures 23 to 26, the close relationship of these four species can not fail to be apparent. With one exception, *C. tennesseensis*, the zoëcia are of equal size. The specific distinctions must, therefore, be based on differences in the aperture, surface ornamentation, and angle of divergence. *C. schucherti* has the most constricted aperture and in this respect is more closely related to the *C. inflata* section than to the present group of species. This relationship is further indicated by the constricted proximal portion of the zoëcium. *C. canadensis*, although of exactly the same size, is less constricted in the proximal area and also has a wider aperture,

which, in addition, is slightly exsert. While *C. schucherti* may be considered as intermediate between *C. canadensis* and *C. inflata*, *C. canadensis* likewise represents a stage between *C. schucherti* and *C.*

*dissimilis*. *C. tennesseensis*, with its exsert aperture and transversely rounded zoëcia, is probably an early expression of the Silurian *C. dissimilis*.

The dimensions for *C. canadensis* are as follows: Average length of zoarium, 0.80 mm.; width at constricted proximal portion, 0.22 mm.; diameter at most expanded part, 0.37 mm.; diameter of aperture, 0.20 mm.

*Occurrence*.—Middle Ordovician, Swampy Island, Lake Winnipeg, Canada.